Jurnal Pendidikan Malaysia 41(1)(2016): 19-24

Teachers' Perceptions on Identifying and Catering to the Needs of Mathematically Gifted and Talented Students

(Persepsi Guru dalam Mengenal Pasti dan Menangani Keperluan Pelajar Pintar dan Berbakat dalam Matematik)

Abraham Ayebo*

ABSTRACT

Giftedness is an elusive concept. The way teachers perceive the meaning of giftedness affects how they teach and attend to the needs of the gifted students in their classrooms. The aim of this study was to examine teachers' views on teaching mathematics to gifted/talented students. The methodological orientation of the study was phenomenological. This qualitative study reports the perceptions of teachers who teach mathematically gifted and talented students on perceived characteristics of mathematical giftedness as well as how to cater to the needs of such students. Interviews were conducted with five teachers who teach mathematics to gifted and talented students. Some of the findings include distinction between gifts and talents, student subgroups and instructional needs of mathematically gifted students.

Keywords: Giftedness; teacher perception; gifted and talented; mathematics

ABSTRAK

Kepintaran merupakan suatu konsep yang sukar difahami. Dari perspektif guru, kepintaran mempengaruhi bagaimana guru mengajar dan mengambil kira keperluan pelajar pintar cerdas di dalam kelas mereka. Tujuan kajian ini adalah untuk mengkaji pandangan guru terhadap pengajaran matematik kepada pelajar-pelajar pintar cerdas / berbakat. Orientasi metodologi kajian ini adalah menggunakan kaedah fenomenologi. Kajian kualitatif melaporkan bahawa persepsi guru yang mengajar matematik pelajar pintar cerdas dan berbakat, ciri kepintaran matematik serta bagaimana untuk memenuhi keperluan pelajar tersebut. Temu bual telah dijalankan dengan lima orang guru yang mengajar matematik kepada pelajar-pelajar pintar cerdas dan berbakat tersebut. Antara penemuan termasuklah terdapat perbezaan antara anugerah dan bakat, kumpulan kecil pelajar dan keperluan pengajaran matematik dalam kalangan pelajar pintar berbakat ini.

Kata kunci: Kepintaran; persepsi guru; pintar dan berbakat; matematik

Introduction

Mathematically gifted students learn differently from their peers. They need special attention and differentiated curriculum to meet their needs (Greenes 1981; Jolley 2005; Lent et al. 1991; McCoach & Siegle 2007; Renzulli 2005; Rotigel & Fello 2004). If they do not receive the learning experiences that are appropriate for their unique talents, they can become uninterested and frustrated and eventually become underachievers (Croft 2003; Hoeflinger 1998). To require mathematically gifted students to participate while concepts are repeated for the rest of the class is generally not a good approach. Studies have shown that curricula in general education classrooms are frequently inappropriate for gifted students. For example, a national study by Heacox (2007) found that an average of 35 to 50 percent of the regular curriculum at the elementary level could be eliminated for gifted students. Krutetskii (1995) also cites research showing that mathematically gifted students can complete a year of grade-level mathematics in three to six months. Mathematically gifted students are more likely to retain mathematics content precisely when taught two to three times faster than the average student (Krutetskii 1995). Thus, schools need to make curricular changes to account for the learning needs of mathematically gifted students. This study was therefore designed to examine teachers' perceptions of mathematically gifted students and how to meet the instructional needs of such students.

Context and Review of Literature

Mathematically gifted and talented students display several characteristics. They are a diverse group of students who demonstrate a wide array of talents and skills. These students have attitudes and characteristics that differ among individual gifted and talented students (Konstantopoulos et al. 2001). Davis and Rimm (2004) indicated that the 1925 Terman study found that mathematically gifted children did not have a sense of security socially and emotionally. However, Davis and

Rimm found that students who had IQ's higher than 145 should have counseling or emotional education as a part of their gifted programs. Other characteristics of mathematically gifted and talented students are cognitive and motivational qualities (Robinson & Clinkenbeard 1998). Such students have advanced cognitive qualities and they are quick and logical thinkers. They are eager to learn, curious to learn, and persistent (Davis & Rimm 2004).

Ruf (2005) explained characteristics of mathematically gifted and talented students in her five levels of giftedness. Ruf (2005) categorized students' levels of giftedness and talent into five levels, ranging from moderate to profound giftedness. Level 1 refers to moderate or high giftedness and ranges from the 90th-98th percentiles on standardized tests. Students within this level of giftedness are in the top one-third to one-fourth of students in a mixed-ability classroom. The IQ scores for some students at this level do not reflect their abilities or meet the criteria for being considered mathematically gifted and talented. Level 2 describes highly gifted or advanced students who score at or above the 98th-99th percentile on standardized tests. High gifted or advanced students typically occur in one out of every three students in a mixed-ability classroom. The third level of mathematical giftedness indicates students with the ability to score in the 98th-99th percentile on standardized tests. Students with advanced IQ tests are highly to exceptionally gifted and live more often near schools with a higher socio-economic status.

The fourth level of giftedness refers to students who score primarily in the 99th percentile on standardized tests, but differ from gifted students in previous levels because they are infrequent and sent to other schools. Gifted students categorized at this level receive home education as well as being identified as profoundly gifted (Ruf 2005). Only two or three students in Level 4 are likely to occur per grade level in schools with a higher socioeconomic status. In most public schools, one or two Level 4 students occur across grade levels. Level 5 children are above the 99th percentile and are students who have high intellectual profiles, are exceptionally rare, and demonstrate a broad distribution of age, location, and time.

One key concept that has been suggested for catering to the learning needs of mathematically gifted and talented students is differentiation. Tomlinson's (1999) work on differentiation informs this study because differentiation is frequently recommended as a strategy to meet the needs of gifted and talented students in the general education classroom. Modifications can be made to differentiate instruction for the gifted learner in the general education classroom according to the interests of the child, the pace of the curriculum, or the depth of the curriculum. Tomlinson (1999) offered four characteristics of the effective differentiated classroom. The first characteristic is that instruction is concept-focused and principle-driven. The next characteristic is that ongoing assessment of student readiness and growth is built into the curriculum. A third characteristic of the effective differentiated classroom is that flexible grouping is consistently used. Tomlinson (2003) defined flexible grouping as "students consistently working in a variety of groups based on readiness, interest, and learning profile, and both homogeneous and heterogeneous in regard to those three elements." A final characteristic of the effective differentiated classroom is that students are active explorers with teachers guiding the exploration.

According to Tomlinson (2003), differentiation is "responsive teaching, [that] stems from a teacher's solid (and growing) understanding of how teaching and learning occur and responds to varied learners' needs for more practice or greater challenge, a more active or less active approach to learning and so on." Tomlinson explains differentiation of instruction as a teacher's response to students' needs, guided by general principles of differentiation. The principles of differentiation include the following: focusing on essentials; attending to student difference; aligning assessment and instruction; modifying content, process and products; working and learning together; respectful tasks; flexible grouping; and ongoing assessment and adjustment.

Tomlinson (2003) recommends that teachers differentiate content, process, or products based on student readiness, interests or learning profile. Readiness refers to a student's knowledge, understanding and skill that designate their entry point within a particular sequence of learning. It can be influenced by factors such as prior experience, attitudes and habits of mind. Interest refers to topics that are of interest and are a passion for the learner. The learning profile refers to how students learn best and includes learning style, intelligence preference, culture and even gender. Tomlinson adds that differentiation can occur through various instructional and management strategies. Some of the more critical strategies she suggests for differentiation include literature circles, tiered lessons, learning contracts, independent study, varied questioning strategies, compacting and varied homework.

Methodology

The aim of this study was to examine teachers' views on teaching mathematics to gifted/talented students. More specifically, the study addressed the following questions: (1.) What student characteristics make a student gifted/talented in mathematics? (2.) What instructional approaches are important for teaching mathematics to gifted/talented students? The methodological orientation of the study was phenomenological. This means that teachers' accounts of their experiences may be understood as descriptions of the essential features of pedagogical interaction, allowing us to comprehend the phenomenon in a new way (Van Manen 1990).

PARTICIPANT

Five research participants, Margaret, Vivian, Emelia, George and Eric (pseudonyms), were selected on a voluntary basis. The group of participants was fairly heterogeneous in terms of their discipline, age and experience as a teacher. Three of the participants were female; two were over fifty years of age, two were between thirty and fifty and one less than thirty years. All five participants were Caucasian. In order to protect the participant's identity, more specific demographic information cannot be provided.

Face-to-face, semi-structured interviews were conducted with each participant. The interviews lasted from thirty to 45 minutes. The questions were open ended to allow participants to tell their stories freely. A typical question, for example, went as follows: "What teaching techniques do you believe are especially important for teaching mathematics to gifted and talented students?" The interviews took place at a mutually agreeable, private place and time. Interviews were audio taped and transcribed.

To address validity of the data, the interview questions were sent to two experienced teachers of gifted/talented students with a review sheet to read through and offer constructive feedback. The feedback received mainly addressed the wording and clarity of the questions. Based on the feedback, the interview questions were either re-worded or deleted. The limitation of the current study is the representativeness of the participants. Thus, the findings and conclusions from this study might not necessarily reflect the views of all teachers of mathematically gifted and talented students.

DATA ANALYSIS

After the data were transcribed, the transcripts were read while listening to the tapes, and initial codes were developed. The participant's story was the real guide to coding the data, and codes were developed as necessary to reflect the themes that appeared in the interview transcript. Once the coding scheme reached a point where it seemed to capture the relevant parts of the participant's story, the interview were re-coded.

FINDINGS

The main themes that were constructed in the data were characteristics of gifted students, distinction between gifts and talents, struggles/challenges for gifted students, instructional needs and student subgroups.

CHARACTERISTICS OF MATHEMATICALLY GIFTED STUDENTS

The characteristics of mathematically gifted students mentioned by participants were understanding of numbers and patterns, communication difficulties, and lack of organization. Sample comments are as follows:

1. Some of the characteristics include their understanding of numbers and patterns; their ability to think about mathematics in a variety of ways, so that mathematics comes naturally to them. They don't struggle at all. They just seem to understand the patterns. Now, sometimes, that doesn't translate, they are not able to show how they understand it. They just understand it, but then they struggle with showing how they got their answer and explaining their thoughts (Vivian).
2. I think that when we hear the word 'gifted', it means they are exceptional. They have a depth of understanding of the mathematical concepts, rather than the mathematical tasks. So you can give them application problems and they jump on it right away. Or they see a clever way or a much more convenient way of proving something, or just analyzing something. So they are operating at those really high levels of understanding and they always do very well on the application problems, extra-credit problems, things like that (Eric).
3. I find that mathematically gifted students tend to do very well on math tests and quizzes. They tend to be lousy and disorganized. Some of them have find it difficult paying attention in class, especially if the lesson is not challenging enough (Margaret).

DISTINCTION BETWEEN GIFTS AND TALENTS

On whether mathematical giftedness and mathematical talent were the same or different, participants' responses were again inconsistent:

1. I always assumed mathematical giftedness and mathematical talent were interchangeable. I would say gift is what you have naturally and talent is what you do with that gift (Margaret)
2. Gift is when you visualize math without having to be trained; talent is when you can learn and be efficient at it. (Vivian)
3. Talent is innate; talented students communicate well, write out their solutions. Gifted students on the other hand are bad at process and communication though functioning at high level in relation to concept understanding (George).

STRUGGLES/CHALLENGES FOR GIFTED STUDENTS

All three participants noted that mathematically gifted children do in fact have areas of struggle that tend to hinder them from reaching their full potential. These difficulties include difficulty in showing/explaining solution processes, answers, and concepts; tendency to become bored more quickly and thus be unmotivated; reduced confidence with general education students due

to being with intellectual peers and fear of failure. Here are sample participants' responses:

1. Showing their understanding and going through the little steps to get the solutions seems to be a huge problems for most mathematically gifted students. They are used to getting the right answers with less effort, and so they struggle with: How did you get that answer? And when they get the answer wrong, they get easily frustrated because they never did the 'baby' steps to get it (Emelia).
2. One of the biggest challenges facing mathematically gifted students is speaking the language of mathematics. They have been so good at math that they are kind of able to bully their way through a math class. They understand the concepts, especially at the lower levels. Once you start getting into the higher-level concepts and higher level thinking, they ran into trouble because they can't communicate in mathematics. And that has to do with symbols, for instance being able to tell the difference between an equal sign and an implied sign. You have to teach them how to express their ideas on a piece of paper. Otherwise, they are just ideas inside their heads. The other challenge is being organized. In my classes, I force them to keep a three-ring binder, where they keep their assignments, homework, exams, syllabi, schedules, calculators, pencils, and so forth. (George)
3. They are often are unmotivated and need to be pushed a bit. It is difficult to keep them motivated in a linear fashion. You have to always keep them motivated and interested else, they lose focus entirely. Also, they tend to be perfectionists and fear to attempt a problem that presents a risk of failure (Vivian)

INSTRUCTIONAL NEEDS

Participants noted that mathematically gifted students should be taught in separate classes from general education students. They further contended that the gifted students must be taught at an appropriate level of challenge – neither too low nor too high. This would require pre-assessing to see what they need to learn and compacting accordingly. Participants also mentioned that teachers should teach mathematics in varied ways to keep students creative; use real-world applications; and learn to think in a different way that values process and problem solving. Sample participants' comments follow:

1. The teacher of the mathematically gifted needs to be organized. You need to have a clear path. You need to have assessment ahead of time. Pretest students to know where they are, what they understand and what they don't understand. I also think it is important to use questioning strategies to build student understanding (Margaret).
2. Generally, I think it is best to teach them in their own classroom. The teacher needs to keep them at the appropriate level of challenge (neither too much nor too little; don't want to bore or frustrate them) (Vivian)
3. The teacher needs to compact materials to suit their needs after pre-assessing to only address what they don't know. This would help eliminate unnecessary repetitions (Eric).

STUDENT SUBGROUPS

Participants noted that actual ability differences were not noted by gender or race/ethnicity. They said performance differences could occur based on background factors such as linguistic background (for English Language Learners) or what students have been exposed to and encouraged in. Here are some typical responses from participants:

1. There is this general notion that somehow boys are better than girls at mathematics. But I think once you get all of them together, you realize that it is not necessarily true. One of my most gifted and talented students that I have ever taught was a Black female, so that breaks the stereotype right away. So I think with the gifted kids, you start seeing those stereotypes fall apart (George).
2. I think race/ethnicity does not necessarily have an direct impact on the mathematically gifted student. It depends on the student. And I think that if their first language is not English, that could hold them back a little bit. With African-Americans, I don't think there is anything holding them back. I have several gifted and talented students that I taught who were African-Americans, and several who were Latinos. I noticed with the Latino students that if their first language is not English and they are still acquiring the language, they might be hesitant because they are afraid of coming our perfect in the way they say their answer (Margaret).

Discussion and Conclusion

The teachers in this study mentioned many of the characteristics that are associated with mathematical giftedness. Many of these characteristics are described in the literature by Diezmann and Watters (2000), Hoeflinger (1998) and Sriranam (2003). Straker (1983) also describes many of the same characteristics and suggests that one should look for indicators such as "a liking of numbers including use of them in stories and rhymes; an ability to argue, question and reason using logical connectives: if, then, so, because, either, or… and pattern making."

Many scholars have noted that the way giftedness is defined and perceived affects how parents, teachers, or school administrators handle the gifted child (Assouline 2003; Callahan et al. 2003; Roedell 1984; Rotigel 2004; Sternberg 2003; Van Tassel-Baska & Johnsen 2007). The teachers in this study did not have a comprehensive,

articulated concept of mathematical giftedness. Their knowledge about some of the characteristics was based primarily on teaching experience and observation of their students' behavior. Potentially, it means that many students could be overlooked in the identification process if teachers do not have knowledge about these types of mathematical giftedness.

Participants from this study mentioned that mathematically gifted students should be presented with materials that are rich in content and that can arouse their natural curiosity. Teaching them material that is below their level causes them to feel bored and disengaged in class. This is consistent with the assertion of Gross (1994) that teachers who teach mathematically gifted children should ensure that the material they present to them is problem based, and rich in content.

Other characteristics of mathematically gifted/talented students participants suggested were: problem solvers, independent learners, and high-level thinkers. These characteristics are consistent with those mentioned by Diezmann (2001). Diezmann contends that mathematically gifted students' capabilities and interests in mathematics can be many years ahead of their age peers. These students require challenging tasks to provide scope for learning and the use of metacognitive skills. Tasks that is too simple for particular students can be modified to increase the level of challenge. Diezmann further notes that a task can be problematized by including more complex numbers in the task, by adding obstacles to solution, by requiring students to engage in novel solution processes, or by requiring students to use particular representations (Diezmann & Watters 2000).

In contrast to many of their age peers, gifted students express an explicit preference for difficult mathematical tasks (Diezmann & Watters 2000). Gifted students may need tasks that introduce them to mathematical ideas beyond those typically addressed for their age group. For example, while most children in their first year at school learn about one digit numbers, gifted students of the same age may seek to develop multi-digit number sense to understand the quantitative information they encounter about topics such as space travel (Diezmann & English 2001). Diezmann goes on to suggest that open-ended investigatory tasks can provide rich learning opportunities for gifted students. These tasks require the application of mathematical knowledge, can be cross-disciplinary, and provide scope for creativity (Diezmann et al. 2001).

Participants also described mathematically gifted students as complex individuals with unique needs to support their strengths and weaknesses. It was interesting to note how participants mentioned that, even among gifted students, each individual is very different. Thus, a one-size-fits-all approach would not work for them. Teachers must strive to understand each gifted child and respond to their needs accordingly.

REFERENCES

Assouline, S.G. 2003. Psychological and educational assessment of gifted children. In *Handbook of gifted education* edited by Colangelo, N. & Davis, G.A. Boston: Allyn & Bacon.

Callahan, C., Cooper, C. & Glascock, R. 2003. *Preparing Teachers to Develop and Enhance Talent: The Position of National Education Organizations*. Retrieved from ERIC Database. ED477882).

Croft, L.J. 2003. Teachers of the gifted: Gifted teachers. In *Handbook of gifted education* edited by Colangelo, N. & Davis, G.A. Boston: Allyn & Bacon.

Davis, G.A. & Rimm, S.B. 2004. *Education of the Gifted and Talented* (5th ed.). Boston, MA: Allyn & Bacon.

Diezmann, C.M. & Watters, J.J. 2000. Characteristics of young gifted children. *Educating Young Children* 6(2): 41-42.260.

Greenes, C. 1981. Identifying the gifted student in mathematics. *Arithmetic Teacher* 28(6): 14-7.

Gross, M.U. 1994. Changing teacher attitudes to gifted students through inservice training. *Gifted and Talented International* 9(1): 15-21.

Heacox, D. 2007. Coaching teachers for success in academically diverse classrooms. *Center for Comprehensive School Reform and Improvement.*

Hoeflinger, M. 1998. Developing mathematically promising students. *Roeper Review* 20: 244-248.

Jolley, J.L. 2005, Spring. Foundations of the field of gifted education. *Gifted Child Today 28*(2): 14-65.

Konstantopoulos, S., Modi, M. & Hedges, L.V. 2001, May. Who are America's gifted? *American Journal of Education* 109(3): 344-382.

Krutetskii, V.A. 1995. *The Psychology of Mathematical Abilities in School Children.* Chicago: University of Chicago Press.

Lent, R.W., Lopez, F.G. & Bieschke, K.J. 1991. Mathematics self-efficacy. Sources an relation to science base career choice. *Journal of Counseling Psychology* 38: 424-430.

McCoach, D.B. & Siegle, D. 2007, Summer. What predicts teachers' attitude toward the gifted? *Gifted Child Quarterly* 51(3): 246-255.

Renzulli, J.S. 2005, Spring. Applying gifted education pedagogy to total talent development for all students. *Theory Into Practice* 44(2): 80-90.

Robinson, A. & Clinkenbeard, P.R. 1998. Giftedness: An exceptionality examined. *Annual Review of Psychology* 49(1): 117-139.

Roedell., W.C. 1984. Vulnerabilities of highly gifted children. *Roeper Review* 6(3): 227.

Rotigel, J. & Fello, S. 2004. Mathematically gifted students: How can we meet their needs? *Gifted Child Today* 27: 46-51.

Ruf, D.L. 2005. *Losing Our Minds: Gifted Children Left Behind*. Scottsdale, AZ: Great Potential Press.

Sriranam, B. 2003. Mathematical giftedness, problem solving, and ability to formulate generalizations: The problem-solving experiences of four gifted students. *Journal of Secondary Education* 15(3): 151-165.

Sternberg, R.J. 2003. Giftedness according to the theory of successful intelligence. In *Handbook for gifted education* edited by Colangelo, N. & Davis, G.A. Boston: Allyn & Bacon.

Straker, A. 1983. *Mathematics for Gifted Pupils*. London: Longman.

Tomlinson, C.A. 1999. *The Differentiated Classroom: Responding to the Needs of All Learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C.A. 2003. *How to Differentiate Instruction in Mixed-Ability Classrooms* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development. Thousand Oaks, CA: Corwin Press.

VanTassel-Baska, J. & Johnsen, S.K. 2007, Spring. Teacher standards for the field of gifted education: A vision of coherence for personnel preparation in the 21st century. *Gifted Child Quarterly* 51(2): 182-205.

Van Manen, M. 1990. *Researching Lived Experience.* New York: State University of New York Press.

Abraham Ayebo*
Department of Mathematics
North Dakota State University
Fargo
ND 58108

*Corresponding author; email: abraham.ayebo@ndsu.edu

Received: 30 September 2014
Accepted: 1 October 2015